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Secured Public Auditing Mechanism - ORUTA for Shared Data in the Cloud

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ABSTRACT:

With cloud data services, it is commonplace for data to be not only stored in the cloud, but also shared across multiple users. Unfortunately, the integrity of cloud data is subject to skepticism due to the existence of hardware/ software failures and human errors. Several mechanisms have been designed to allow both data owners and public verifiers to efficiently audit cloud data integrity without retrieving the entire data from the cloud server. However, public auditing on the integrity of shared data with these existing mechanisms will inevitably reveal confidential information—identity privacy—to public verifiers. In this paper, we propose a novel privacy-preserving mechanism that supports public auditing on shared data stored in the cloud. In particular, we exploit ring signatures to compute verification metadata needed to audit the correctness of shared data. With our mechanism, the identity of the signer on each block in shared data is kept private from public verifiers, who are able to efficiently verify shared data integrity without retrieving the entire file. In addition, our mechanism is able to perform multiple auditing tasks simultaneously instead of verifying them one by one. Our experimental results demonstrate the effectiveness and efficiency of our mechanism when auditing shared data integrity.

1 INTRODUCTION:

CLOUD service providers offer users efficient and scalable data storage services with a much lower marginal cost than traditional approaches [2]. It is routine for users to leverage cloud storage services to share data with others in a group, as data sharing becomes a standard feature in most cloud storage offerings, including Dropbox, iCloud and Google Drive. The integrity of data in cloud storage, however, is subject to skepticism and scrutiny, as data stored in the cloud can easily be lost or corrupted due to the inevitable hardware/ software failures and human errors [3], [4].

To make this matter even worse, cloud service providers may be reluctant to inform users about these data errors in order to maintain the reputation of their services and avoid losing profits [5]. Therefore, the integrity of cloud data should be verified before any data utilization, such as search or computation over cloud data [6]. The traditional approach for checking data correctness is to retrieve the entire data from the cloud, and then verify data integrity by checking the correctness of signatures (e.g., RSA) or hash values (e.g., MD5) of the entire data.Certainly, this conventional approach able to successfully check the correctness of cloud data. However, the efficiency of using this traditional approach on cloud data is in doubt. The main reason is that the size of cloud data is large in general.

Downloading the entire cloud data to verify data integrity will cost or even waste user’s amounts of computation and communication resources, especially when data have been corrupted in the cloud. Recently, many mechanisms have been proposed to allow not only a data owner itself but also a public verifier to efficiently perform integrity checking without downloading the entire data from the cloud, which is referred to as public auditing. In these mechanisms, data is divided into many small blocks, where each block is independently signed by the owner; and a random combination of all the blocks instead of the whole data is retrieved during integrity checking . A public verifier could be a data user (e.g. researcher) who would like to utilize the owners data via the cloud or a third-party auditor (TPA) who can provide expert integrity checking services. Existing public auditing mechanisms can actually be extended to verify shared data integrity and data freshness. However, a new significant privacy issue introduced in the case of shared data with the use of existing mechanisms is the leakage of identity privacy to public verifiers .To protect the confidential information, it is essential and critical top reserve identity privacy from public verifiers during public auditing.

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We believe that sharing data among multiple users is perhaps one of the most engaging features that motivate cloud storage. Therefore, it is also necessary to ensure the integrity of shared data in the cloud is correct.

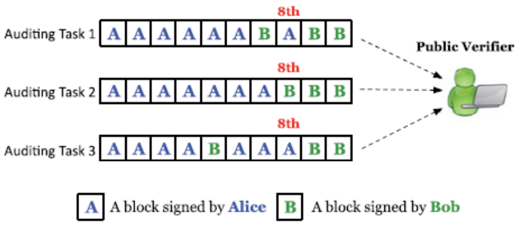


Fig.1. Alice and Bob share a data file in the cloud, and a public verifier audits shared data integrity with existing mechanisms.

Existing public auditing mechanisms can actually be extended to verify shared data integrity [1], [5], [19], [20]. However, a new significant privacy issue introduced in the case of shared data with the use of existing mechanisms is the leakage of identity privacy to public verifiers [1]. In this paper, to solve the above privacy issue on shared data, we propose Oruta,1 a novel privacy-preserving public auditing mechanism. More specifically, we utilize ring signatures [21] to construct homomorphic authenticators [10] in Oruta, so that a public verifier is able to verify the integrity of shared data without retrieving the entire data—while the identity of the signer on each block in shared data is kept private from the public verifier.

TABLE 1
Comparison among Different Mechanisms

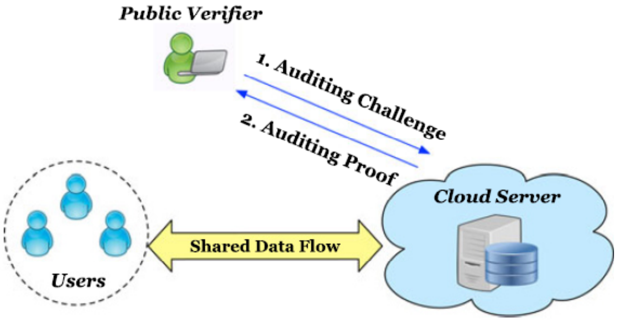
	PDP [9]	WWRL [5]	Oruta
Public Auditing	√	√	√
Data Privacy	×	√	√
Identity Privacy	×	×	√

In addition, we further extend our mechanism to support batch auditing, which can perform multiple auditing tasks simultaneously and improve the efficiency of verification for multiple auditing tasks. Meanwhile, Oruta is compatible with random masking [5], which has been utilized in WWRL and can preserve data privacy from public verifiers. Moreover, we also leverage index hash tables from a previous public auditing solution [15] to support dynamic data. A high-level comparison among Oruta and existing mechanisms is presented in Table 1.

2 PROBLEM STATEMENT

2.1 System Model:

As illustrated in Fig. 2, the system model in this paper involves three parties: the cloud server, a group of users and a public verifier. There are two types of users in a group: the original user and a number of group users. The original user initially creates shared data in the cloud, and shares it with group users. Both the original user and group users are members of the group. Every member of the group is allowed to access and modify shared data. Shared data and its verification metadata (i.e., signatures) are both stored in the cloud server. A public verifier, such as a thirdparty auditor providing expert data auditing services or a data user outside the group intending to utilize shared data, is able to publicly verify the integrity of shared data stored in the cloud server. When a public verifier wishes to check the integrity of shared data, it first sends an auditing challenge to the cloud server. After receiving the auditing challenge.



cloud server responds to the public verifier with an auditing proof of the possession of shared data. Then, this public verifier checks the correctness of the entire data by verifying the correctness of the auditing proof. Essentially, the process of public auditing is a challenge and-response protocol between a public verifier and the cloud server [9].

2.2 Threat Model:

Users are able to access and to share resources offered by cloud service providers at a lower marginal cost. It is routine for users to leverage cloud storage services to share data with others in a group, as data sharing becomes standard feature in most cloud storage offerings, including Drop box, iCloud and Google Drive. The integrity of data in cloud storage, however, is subject to skepticism and scrutiny, as data stored in the cloud can easily be lost or Corrupted due to the inevitable hardware/software failures and human errors. The traditional approach for checking data correctness is to retrieve the entire data from the cloud, and then verify data integrity by checking the correctness of signatures (e.g., RSA) or hash values (e.g., MD5) of the entire data. Certainly, this conventional approach ableto successfully check the correctness of cloud data. However, the efficiency of using this traditional approach on cloud data is in doubt.

3 PRELIMINARIES:

In this section, we briefly introduce cryptographic primitives and their corresponding properties that we implement in Oruta.

3.1 Bilinear Maps:

Let G1, G2 and GT be three multiplicative cyclic groups of prime order p, g1 be a generator of G1, and g2 be a generator of G2. A bilinear map e is a map e: G1 _ G2 ! GT with the following properties:_ Computability: there exists an efficiently computable algorithm for computing map Bilinear maps can be generally constructed from certain elliptic curves [27]. Readers do not need to learn the technical details about how to build bilinear maps from certain elliptic curves. Understanding the properties of bilinear maps described above is sufficient enough for readers to access the design of our mechanism.

3.2 Ring Signatures:

The concept of ring signatures was first proposed by Rive stet al. [28] in 2001. With ring signatures, a verifier is convinced that a signature is computed using one of group members' private keys, but the verifier is not able to determine which one. More concretely, given a ring signature and a group of d users, a verifier cannot distinguish the signer's identity with a probability more than 1=d. This property can be used to preserve the identity of the signer from a verifier. The ring signature scheme introduced by Boneh et al.[21] (referred to as BGLS in this paper) is constructed on bilinear maps. We will extend this ring signature scheme to construct our public auditing mechanism.

4 CONCLUSION AND FUTURE WORK:

In this paper, we propose Oruta, a privacy-preserving public auditing mechanism for shared data in the cloud. We utilize ring signatures to construct homomorphic authenticators, so that a public verifier is able to audit shared data integrity without retrieving the entire data, yet it cannot distinguish who is the signer on each block. To improve the efficiency of verifying multiple auditing tasks, we further extend our mechanism to support batch auditing. There are two interesting problems we will continue to study for our future work. One of them is traceability,which means the ability for the group manager (i.e., the original user) to reveal the identity of the signer based on verification metadata in some special situations. Since Oruta is based on ring signatures, where the identity of the signer is unconditionally protected [21], the current design of ours does not support traceability. To the best of our knowledge, designing an efficient public auditing mechanism with the capabilities of preserving identity privacy and supporting traceability is still open. Another problem for our future work is how to prove data freshness (prove the cloud possesses the latest version of shared data) while still preserving identity privacy.

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